EFFECT OF INORGANIC AND IMPROVED COMPOST FERTILIZER ON YIELD ATTRIBUTES AND YIELD OF SWEET POTATO

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*This is to certify that thesis entitled, "**EFFECT OF INORGANIC AND IMPROVED COMPOST FERTILIZER ON YIELD ATTRIBUTES AND YIELD OF SWEET POTATO**" submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in AGRICULTURAL BOTANY, embodies the result of a piece of bona fide research work carried out by **Wasika Afrin Tithy**, Registration No.: **12-05129** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has been fully acknowledged.

Dated: June, 2020
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Dedicated to

My

Beloved Parents

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ABSTRACT

A field experiment was conducted to study the effect of inorganic and improved compost fertilizer on yield attributes and yield of sweet potato. The experiment was held in the research field of department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, during the period from November 2018 to March 2019. In the experiment the treatment consisted of seven levels of fertilizer doses viz. T_o= No fertilizer (control), T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% rec. dose of BARI+1 kg improved compost fertilizer/m^2, T_4= 50% rec. dose of BARI+2 kg improved compost fertilizer/m^2, T_5= 100% rec. dose of BARI+1 kg improved compost fertilizer/m^2, T_6= 100% rec. dose of BARI+ 2kg improved compost fertilizer/m^2 and the variety here in this experiment was BARI Sweet Potato – 12. The one factor experiment was laid out in Randomized Complete Block Design (RCBD) with these seven levels of fertilizer doses. Three replications were maintained in this experiment. The experiment revealed that T_5 treatment (100% rec. dose of BARI+1 kg improved compost fertilizer/m^2) showed better results in most of the cases and it also showed the highest yield (43.604 ton/ha) of sweet potato variety than the other treatments. On the other hand, T_0 treatment (T_0 = No fertilizer) showed the lowest growth and yield (14.465 ton/ha) here in this experiment. So, it can be concluded that 100% recommended BARI dose+ 1kg improved compost fertilizer/m^2 (T_5) is the best treatment to apply for obtaining better growth and yield from BARI Sweet Potato-12 plant. Hence, it is suggested that these remunerative treatment of inorganic and compost fertilizer's doses help in successful crop production of sweet potato.

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LIST OF ABBREVIATION AND ACRONYMS

AEZ	=	Agro-Ecological Zone
AOAC	=	Association of Official Analytical Chemists
ASHS	=	American Society for Horticultural Science
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
^{o}C	=	Degree Celsius
CIP	=	International Potato Center
CV%	=	Percentage of Coefficient of Variance
DAFF	=	Department of Agriculture, Forestry and Fisheries
DAT	=	Days After Transplanting
e.g.	=	Exempli Gratia (Latin)
et al.	=	And others
FAO	=	Food and Agriculture Organization
FAOSTAT	=	Food and Agriculture Organization Statistical Database
Fig.	=	Figure
gm	=	gram(s)
ha^{-1}	=	Per hectare
kcal	=	Kilocalorie
kg	=	Kilogram(s)
LSD	=	Least Significant Difference
Max	=	Maximum
Min	=	Minimum
MT	=	Metric Ton
MTW	=	Marketable Tuber Weight
MoP	=	Muriate of Potash
m^2	=	Meter square

NPK	=	Nitrogen, Phosphorous and Potassium
NS	=	Non significant
SAU	=	Sher-e-Bangla Agricultural University
RCBD	=	Randomized Complete Block Design
TCRC	=	Tuber Crop Research Center
TSP	=	Triple Super Phosphate
TSS	=	Total Soluble Solid
viz.	=	videlicet (Latin)
wt.	=	Weight
%	=	Percent

CHAPTER I

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) ranked as seventh most important food crop of the world after wheat, rice, maize, potato, barley and cassava (ASHS, 2007; Jan low *et al*, 2015). It is a perennial herbaceous dicotyledonous species of the morning glory family Convolvulaceae and it can also be grown as an annual crop (Woolfe, 1992). Sweet potato originated from Central America and North-Western parts of South America (Mandal, 2006; Lewthaite, 2004). Globally sweet potato is cultivated in 117 countries in an area of 8.62 million ha producing 105.19 million tons with a yield of 12.20 t ha-1 (FAO, 2016). Africa is the world largest sweet potato growing region and majority of the sweet potato production about 95 per cent comes from developing countries, of which China having the maximum share of 67.09% (FAO, 2016).

Sweet potato are traditionally considered to be hardy crops and it is a rich source of carbohydrates, vitamins and minerals for the poor farmers in many developing countries and also it can produce more edible energy per ha per day than wheat, rice or cassava (Jan low *et al.*, 2015) . The major carotenoid β-carotene is highly present in orange-fleshed sweet potato like BARI Sweet Potato- 12 and this β-carotene is a precursor of vitamin A and essential micronutrient for immune functions in human being. The orange colour is given by the high content of ß-carotene: 11,500 mg per 100g of product, compared with only 6 mg contained by potatoes, and even with 40% more than carrots. The beta-carotene is converted by the human body into vitamin A, with beneficial effects on the immunity enhancement, skin health and membranes lining e.g. the nose, lungs and intestines. A sweet potato provides about half of the necessary nutritional vitamin E and contains significant amounts of other vitamins and minerals. A 100 g of sweet potato has the following nutritional quality: 105 kcal energy; 2.22 g proteins; 74.43% water; 14.43% starch; 3.48% total sugar; 0.58% glucose; 1.10% cellulose. Due to the biochemical composition and large production per unit area (above 40 t/ha) it is a good source of food in many least developed countries with problems of nutrition (Tian *et al.*, 1991).

In present time it is becoming the focus for research due to the versatility and adaptability of sweet potato in various climatic conditions. Sweet potato is one of the main crops as majority of farmers consider it as major source of food mainly for human consumption and having substantial role by ensuring food security and increasing the income of farmers (Prakash *et al.*, 2016; Prakash *et al.*, 2017). The total production of sweet potato here in Bangladesh has been increased from 92,479 to 104,000 MT in 2000 to 2016, respectively (FOASTAT, 2017).

Fertilizer is one of the most important inputs of increasing the productivity of crops (Anon., 1997). In order to obtain good yield, modern varieties of different crops require relatively high quantity of fertilizer compared to the traditional cultivars. Because of the economic condition of Bangladesh, farmers often does not support themselves to use required quantity of fertilizers due to its high cost. Again, the organic matter content of most of the soils of Bangladesh is very low (0.8-1.8%) as compared to desired (2.5% and above) levels (Hossain *et al*., 1995). Therefore, it becomes an immense need to formulate an optimum fertilizer recommendation that would produce satisfactory yields and would maintain soil health to ensure sustainable crop production. Bhuiya and Akanda (1982) reported that organic matter in combination with chemical or inorganic fertilizer showed excellent response to crop cultivation.

Sweet potato grows best in sandy, well drained soils. As there is less amount of organic matter in sandy soil, the fertility can be enriched with the application of inorganic and improved compost fertilizer. Inorganic fertilizer when applied to crop usually has a quick-released formula making nutrients rapidly available to plants whether compost is a good source of organic fertilizer for different essential plant nutrients to be added in soil and sustain crop yields (Chelah *et al*., 2011). According to Baskoro (2010), water content in soils amended with compost tends to be high compared to that without compost application. The application of fertilizers and supplement irrigation during the growth stage results in a higher percentage of well shaped, marketable tubers.

In order to assist farmers in improving production practices, agronomic data on the performance of this crop must be generated. The results of this experiment will represent the type of information that is required by farmers who wish to obtain high yielding varieties of sweet potato suitable for planting within the particular land.

In view of this, the objectives of this study were :

1. To find the effect of inorganic fertilizer on sweet potato
2. To observe the effect of improved compost fertilizer on sweet potato
3. To investigate the effect of inorganic and improved compost fertilizer on sweet potato, in the first crop cycle

CHAPTER II

REVIEW OF LITERATURE

A field experiment was conducted at the Sher-e-Bangla Agricultural University to study the effect of inorganic and improved compost fertilizer on yield attributes and yield of sweet potato. Some related research findings of different researchers have been cited below.

Sweet potato is a dicotyledonous root tuber crop which belongs to the Convolvulaceae family. Sweet potato is distantly related to the potato (*Solannum tuberosum*) that belongs to the nightshade Solanaceae family, having the same order Solanales. In some parts of North America, the soft orange sweet potato is known as 'Yam' though it is botanically different from original Yam (Dioscorea). Dioscorea is monocot that belongs to Dioscoreaceae family and native to Africa and Asia. In Argentina, Venezuela, Puerto Rico and the Dominican Republic sweet potato is known as 'batata'. In Maxico, Peru, Chile, Cantral America and Phillipines sweet potato is called camote (Annonymous, 2016).

Sweet potato (*Ipomoea batatas* (L.) Lam.) was botanically described in 1753 by Linnaeus as *Convolvulus batatas* but Lamarck, in 1791 re-classified the crop into the genus *Ipomoea* on the basis of the stigma shape and the surface of the pollen grains (Thottappilly and Loebenstein, 2009). That is why, this crop belongs to the family of Convolvulaceae, tribe of Ipomoeae, genus *Ipomoea*, sub-genus *Eriospermum*, section *Eriospermum* and species *batatas.* Therefore, the botanical name of sweet potato was changed to *Ipomoea batatas* (L.) Lam. Sweet potato is an important staple crop of most tropic countries and it is mainly known for its vigorous growth, drought resistance and productivity with minimum inputs. (Rahman *et al*., 2015)

Color of the leaves and stem varies from green to dark purple because of the presence of anthoclyanine pigment (Laurie and Niederwieser, 2004). The general leaf outline varies from round to almost divided with the margins having no lateral lobes to deeply lobes. The size and shape of the storage root varies from round and long irregular or curved because of the variety and environmental factors (Woofle, 1992). The skin color of sweet potato varies from white to dark purple and flesh color varies from white to orange depending on distributions (Laurie and Niederwieser, 2004). Sweet potato has an increased storage root which accumulates more edible components compared to tuber potato.

It is well established that high quality food can be produced using either organic or inorganic nutrient sources. If differences occur between crops produced with organic or inorganic fertilizers, they usually occur from differences in amount and balance of nutrient supplied (Worhtington, 1998). A trial result have indicated that when the amount of basic nutrients (NPK) applied with organic and mineral fertilizers were equal, there were no significant differences in the biological yield and quality of crop (Jarvan, 2006; AOAC, 1984).

Nitrogen requirements can vary among cultivars, geographic locations, climates and cropping seasons (Smith and Villordon, 2009). On most soils, nitrogen application increases tuber yield, however, excess nitrogen stimulates foliage production at the expense of tubers and may lead to tuber cracking. Nitrogen application is effective only if a N:K_2O ratio of 1:1.5 to 1:2 is realised (Roy *et al*., 2006).

Sweet potato is considered to be relatively tolerant of low phosphorous levels of soil. Increased rates of phosphorous fertilizers do not have significant effect neither on yield nor on storage quality (Stoddard, 2015). Mycorrhizza play an essential role in the phosphorous supply of sweet potato (O'Keefe and Sylvia, 1992). Inoculation of sprouts with vesicular-arbuscular mycorrhizal (VAM) isolates increase the storage root yield (O'Keefe and Sylvia , 1993). Sweet potato varieties, however, differ in the level of mycorrhizal infection and in the response to the applied phosphorous (Mulongoy *et al*., 1988). Like other root crops, sweet potato also has a high requirement for potassium, its yield and quality responding strongly to potassium application (Liu *et al*., 2013). Appropriate levels of potassium fertilizers can contribute to more assimilates during the early and middle growth stages but also have higher sink strength of storage roots leading to higher assimilate distribution in storage roots in the later growth stages (Liu *et al*., 2013). Increased potassium doses result in higher number of tubers/plant, weight of tubers/plant and tuber yield/ha. Various cultivars, however, respond differently to potassium, the responsive ones developing longer vines, higher number of leaves and branches/plant as well as heavier vine dry weight (Uwah *et al*., 2013; Dumbuya, 2015).

Regarding the form of potassium fertilizer, potassium sulphate can result in higher tuber starch content, while potassium chloride increases fresh weight and overall starch yield

(Lu *et al*., 2001). However, according to Roy *et al*., (2006), potassium chloride can depress root dry-matter content, for this reason the use of potassium sulphate or a mixture of the two sources is recommended.

High levels of nitrogen are not required for optimal storage root initiation (13 days after transplanting). On the other hand, maximum nitrogen uptake by storage roots is at the 23 and 40 days following transplanting (Smith and Villordon, 2009).

Pulok *et al*. (2016) conducted an experiment on the effect of potassium (K) and mulch materials on grading of different types of tuber which was investigated at the Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2013 to March 2014. The experiment comprised of four different doses of K viz., 0 kg K ha^{-1}, 100 kg K ha^{-1}, 125 kg K ha^{-1}, 150 kg K ha^{-1} and four different types of mulch materials viz., soil mulch, rice straw, water hyacinth and saw dust. The experiment was laid out in a split plot design with 3 replications. Maximum large sized tubers were produced by 150 kg K ha^{-1} with rice straw mulch.

Iheagwara (2013) reported that the sweet potato (Ipomoea batatas L (Lam)) starch was isolated and subjected to physical, chemical and enzymatic modifications that generates hydrothermally modified (HMSPS), acid modified (AMSPS) and enzymatically modified (EMSPS) sweet potato starches. The proximate, physicochemical, pasting characteristics, light transmittance, freeze thaw stability of the native and modified starches were characterized. Results obtained the experiment revealed that moisture, ash and protein contents were reduced following modifications. Hydrothermal modification (HMSPS) caused an increase in swelling power, solubility and water binding capacity whereas acid and enzymatic modifications reduced them. There was also a significant reduction ($P \leq 0.05$) in sediment volume of all the modified starches with EMSPS (1.41 ml) having the least value. Breakdown (BD) and peak viscosity (PV) values declined for all modification with EMSPS having the least values of 519cP and 2027cP respectively for BD and PV. However, EMSPS and AMSPS exhibited improved pasting characteristics, freeze-thaw stability and paste clarity.

Another study showed that the most important characters for distinction of the accessions were leaf outline, leaf lobe type, leaf lobe number, and shape of the central leaf lobe. The study provided comprehensive information concerning locally available sweet potato germplasm and is of vital importance for advancement in the sweet potato improvement program in South Africa. The information will also be useful to SASHA (a regional network for sweet potato breeding), ensuring wider utilization of these germplasms within Sub-Saharan Africa (Laurie *et al*., 2013).

Liang (2013) studied the effects of potassium fertilizing on yield of summer sweet potato variety Longshu24 and reported that yield of sweet potato was increased dramatically and also increased the starch content of the tuber.

Potassium (K), one of the key nutrients is needed for a sweet potato plant to thrive. Potassium (K) impacts the plant's ability to efficiently use nitrogen and aids water uptake. K is also essential for improving nutrient value, enhancing taste, color and texture, promoting disease resistance, optimizing yield and grade (Sweet Potato Research Station, 2007). Jian-wei *et al.* (2001) studied and found that the yield and yield contributing characters of sweet potato increase due to the application potassium (K).

Field experiments were conducted during the two successive spring seasons of 2008 and 2009 in the International Potato Center (CIP), Agriculture Research Center (ARC), Kafr El-Zayat, El-Gharbia Governorate, Egypt to observe the effect of different levels of potassium fertilization and foliar application of different rates of zinc on sweet potato (Ipomoea batatas L) (cv. Abeese) 2 performance. Four rates of potassium fertilizer (60, 90, 120 and 150 kg K_2O/fed.) in the form of 2 potassium sulfate (48% K_2O) and four levels of foliar zinc fertilizer (0, 10, 20 and 30 ppm) in the form of zinc sulfate were applied. The individual effects identified that the highest sweet potato yield 2 was obtained from plants received 150 kg K_2O/fed., while the lowest root yield was obtained 2 from control treatment (60 Kg K_2O/fed.). On the other hand, the highest zinc dose recorded the highest production of root yield compared with other low doses. The interaction effect between potassium and zinc fertilizer showed the highest value of vegetative growth, yield and quality of roots when potassium and zinc were applied at the highest levels (El-Baky *et al*., 2010).

The rizoderm of the thickened roots has different colours (white, cream, yellow, orange, pink, red to purple.), and the pulp has shades of ivory, orange or purple-lilac (Abubakar *et al*., 2010; Away *et al*., 2013). According to the estimations of the Center for Science in the Public Interest, the nutritional value of sweet potato is more impressive than the one of common potato. In comparison to the latter, the sweet potato has a much higher content of retinol equivalents, especially β-carotene. A study carried out in Uganda in

2012, which involved approx. 10,000 households showed that: "Only 10% of those who consume dark orange sweet potatoes suffer from vitamin deficit, retinol equivalents, while 50% of those who consume beige or pale yellow sweet potato have a significant hypovitaminosis"; this is explained by the higher content of β-carotene of dark orange sweet potatoes in comparison to the lighter ones (Coghlan, 2012)

High nitrogen applications stimulate vine growth as well as root production (Johnson and Ware (1948). However, when nitrogen needs are satisfied, the additional nitrogen goes into vine production. Should potassium levels in the soil be in limited supply, high nitrogen application can induce potassium deficiencies and limit root yields at the expense of vine production. It was felt that increasing the potassium levels in the presence of high nitrogen could offset the harmfull effect of the nitrogen on root yields.

Stino (1953) working with sweet potatoes on a fertile clay loam in Egypt found that increasing phosphate in relation to potash from 0 : 2 to 1.5 : 2 P : N ratio gave a limited and variable response in root yield but ever increasing vine yield. Cibes and Samuels (1957) obtained large increases in vine growth at the expense of root production under phosphorus deficiencies in sweet potatoes.

A field experiment conducted by Gezahegn *et al*., 2014 at Delbo watershed Wolaita Zone, Southern Ethiopia noticed that the root yield of sweet potato (Ipomoea batatas (l.) lam.) increased by the combined effects of inorganic NP and farmyard manure (FYM) fertilizers application. A field experiment carried by Teklu *et al*., 1999-2001 at Debre Zeit on Andosols to evaluate the effects of farmyard manure and inorganic fertilizers application on productivity of horticultural crops (shallot, cabbage and potato) indicated that the yield of the crops increased due to combined application of farmyard manure and inorganic fertilizers.

Sweet potato has a high requirement for potassium relative to nitrogen. However due to unavailability of straight K fertilizer in the market, wood ash could be an alternative and cheaper source of K that is available. The K_2O concentration in the wood ash was analyzed and discovered to be about 3 percent. Thus, ash could be an important source of potassium for sweet potato production (Tsuno and Fujise, 1965)

In India, the mixed farming system with livestock raising is an integral part of crop production. The availability of large quantity of FYM being rich in organic matter need for supplementing the nutrients. The organic manure (FYM) not only provides nutrient to the plant but also improves the soil texture by binding effect to soil aggregates. Organic manure increases CEC, water holding capacity and phosphate availability of the soil besides improving the fertilizer use efficiency and microbial population of soil, it reduces nitrogen loss due to slow release of nutrients.

In recent years, use of vermicompost has been advocated in integrated nutrient management (INM) system in vegetable crops. Vermicompost means a mixture of worm casting, organic materials, humus, living earthworms, their cocoons and other organisms. Vermicompost is a slow releasing and organic manure which have most of the macro as well as micro nutrients in chelated form and fulfill the nutrient requirement of plant for longer period. Vermicompost helps in reducing C:N ratio, increased humic acid content, cation exchange capacity and water soluble carbohydrates (Talashilkar *et al*., 1999). It also contains biological active substance such as plant growth regulators.

Jones (1986) observed that many of sweet potato traits are quantitatively inherited. The phenotype of a quantitative trait occurs due to genotypic and environmental effects. For that reason, estimates of variability and its heritable components for the yield attributing characters available in the sweet potato germplasm are pre-requisite for high yield breeding program. Again, genetic-statistical methodologies are available that assists in selection of superior parents based on their combining ability and potentiality to produce promising segregating populations (Griffings, 1956).

Improvement of a crop mainly relies on the magnitude of genetic variability and the extent of heritable desirable characters. Sweet potato is a crop having wide range of variability in different agro-morphogenic characters like tuber skin, flesh colour, shape of tuber, time of maturity, resistance to disease, leaf shape and several other characters which can be utilized for the development of a desirable genotype. Existence of genetic diversity in a crop population and proper knowledge on this divergence is of great importance to breeders. Breeders can manipulate this divergence for improvement breeding of a crop. So, an attempt has been made to collect the background information on the amount of genetic variability present in sweet potato genotypes and this attempt can assist as a guideline to select parents as a donor in breeding program for proper utilization of the quality trait and development of the desirable varieties for various agro-ecological zones (AEZ) in Bangladesh. The effect of environment in expression of desirable traits also need to be taken into account. Burton (1952) stated that co-efficient of variability along with heritability estimation will provide a landscape of genetic advance which can be obtained by selection process. Several works has already been done to find out wide range of genetic variability for characters of vine and tubers of sweet potatoes (Rao *et al*., 1992; Vimala and Lakshmi, 1990; Kamalam, 1990; Kamalam *et al*., 1977; Lowe and Wilson, 1975; Hayneys and Wholey, 1971; Jones *et al*, 1969; Mc Lean, 1955).

Variation refers to the occurrence of differences among the individuals due to the differences in their genetic composition and the environmental effect (Allard, 1960). Sweet potato has a wide range of adaptability to harsh growth condition but still sensitive to environmental variation. The study of magnitude of variability of a crop species is important as it provides the basis for effective selection (Singh, 1993). Information regarding the nature and magnitude of genetic variability of a crop helps in designing effective crop breeding program for producing hybrids (Poehlman and Sleper, 1995). In crop improvement, plant breeder selects crop on the basis of their phenotype and the effectiveness of the selection that would largely depend on the proportion of the phenotypic variation due to the genotype (Amsalu, 1993). The genetic component of variation is important in crop improvement, since only this component is transmitted to the next generation (Singh, 1993). Again, phenotypic variation is the observable variation which is present in a character in population. It includes both genotypic and environmental components of variation and as a result, its magnitude differs under different environmental conditions (Singh 1993). Genotypic variation is the component of variation which is due to the genotypic differences among individuals within a population.

Wilckens *et al*. (1993) studied on 32 accessions of sweet potato and observed that 5 and 27 accessions showed variability for morphological characters like type of leaf lobbing, shape of the central leaves, petiole pigmentation and root flesh colour. Choudhary *et al*. (2001) experimented on 21 morphological traits in sweet potato like nature of twining, plant type, vine pigmentation, vine tip pubescence, vine inter node length and diameter, vine growth rate, petiole pigmentation, petiole length, foliage colour, abaxial leaf vein pigmentation, mature leaf shape, mature leaf size, flowering habit, flower colour, seed capsule setting, tuber neck length, tuber shape, tuber skin colour, tuber flesh colour, distribution of anthocyanin in tuber flesh and latex production in tuber and they observed wide range of variations in these traits. According to Kaledzi *et al*. (2010) who studied on 40 accessions of sweet potato, they observed variations among the different accessions in terms of the vine, leaf, petiole, root skin and flesh characteristics.

Sreekanth *et al*. (2011) conducted a preliminary yield trial with 230 clones selected from 1600 orange fleshed clones for morphological observations like leaf shape, emerging leaf colour, skin colour, flesh colour, weight of vine and weight of storage roots and observed that selection of a number of superior hybrid clones based on yield and yield contributing attributes would provide a large gene pool for the recombinations. Wadud *et al*. (2011) had an experiment on sweet potato genotypes on the basis of leaf, vine and tuber characters and reported that leaf character varied from heart, tetralobbed to pentalobbed, the vine and vine tip colour ranged from green, pink, pinkish green, light purple, deep purple to light pink, and the shapes of tuber were globulose, elliptical and fusiform respectively. Vimala *et al*. (2011b) studied on 1600 orange fleshed sweet potato genotypes and found wide range of genetic variation for skin colour of tuber (pink, purple and purple to light pink colour) and root flesh colour (orange, light orange, dark orange and creamy to yellow colour). Vimala *et al*. (2012) evaluated 1630 orange fleshed sweet potato genotypes and observed three types of leaf shapes like cordate (81.65%), slightly lobed (16.69%) and narrow lobed (1.66%) and emerging leaf colour ranged between green (92.5%) to purple (7.5%). In a study, Richardson (2012) evaluated six genotypes of sweet potato for tuber quality and found large variation in the leaf and tuber characteristics.

Kamalam (1990) experimented on fifteen sweet potato cultivars and observed very high variability for some quantitative traits like vine length, vine thickness, number of branches, number of Tuber and tuber yield. Wilckens *et al*. (1993) studied 32 accessions of sweet potato and observed that 5 and 27 accessions showed variability for growth habit and internode length respectively.

Tsegaye *et al*. (2007) conducted a study on 30 sweet potato genotypes and observed that there was significant variability among the genotypes for the characters like vine length, vine inter node length, vine inter node diameter, leaf area, above ground fresh and dry weight per plant, storage root number per plant, storage root length and diameter, individual storage root weight, harvest index per plant, storage root dry matter content and storage root fresh yield per plot.

Cavalcante *et al*. (2010) conducted a trial on 9 clones and 2 varieties of sweet potato and revealed that, clones 6 and 11 presented the highest marketable root yield and clones 8, 14 and the “Rainha Prata” variety showed the highest phytomass yield on the shoot. Binu *et al*. (2011) studied the changes in dry matter content during 35 days of storage in 10 orange fleshed sweet potato clones and observed that gradual decreases in dry matter content from 24.1 to 25.5 %. Vimala and Hariprakash (2012) evaluated 250 hybrid progenies on the basis of vine, fresh yield per plant, fresh yield per plot, storage root and dry matter content and observed that the selection of a number of superior F_1 clones for yield and other attributes would provide a large gene pool for the recombination to generate the promising variety of considerable value.

Miller (1958) studied and observed high carbohydrate and starch content, in different genotypes which may be due to variation in the genetic makeup of the genotype. Teshome *et al*. (2003) reported highest starch content in clone IGSP-9 (34.66%) and lowest in RNSP-1 (16.38%) under coimbatore conditions. Sahu (2003) reported highest total soluble solids in genotypes IB-90-15-9 for Chhattisgarh plains. Vimala *et al*. (2009) evaluated 40 clones of orange fleshed sweet potato during different season like summer, kharif and rabi to find out the variability of carotenoids, β- carotene and observed that total carotenoid content ranged from 8.5-15.0 mg/100g fresh weight and β carotene varied from 6.8-13.7 mg/100g fresh weight. Binu *et al*. (2011) studied the changes in carotenoid content during 35 days of storage in 10 orange fleshed sweet potato clones at Central Tuber Crop Research Institute, Thiruvanthapuram, Kerala and evaluated that significant variation in total carotenoids content (10.3213.99 mg/100g fresh weight) and β-carotene (9.02-12.6 mg/100 g fresh weight) among the clones.

The crude protein content of sweet potato (Kjeldahl nitrogen × 6.25) generally ranges from 1.3% to > 10 % dwb (Bradbury *et al*., 1985; Purcell *et al*., 1978). Substantial variation has been shown to exist. Ishida et al. (2000) reported 2.1% and 1.3% protein for Koganesengan and Beniazuma sweet potato cv., respectively. Diop (1998) reported 1.0–2.4% protein in sweet potato while Bovell-Benjamin *et al.* (2001) and Dansby and Bovell-Benjamin (2003a) stated that protein contents ranging from 1 .2 ± 0. 05% to 1 .8% (fresh weight) for hydroponically grown sweet potatoes. Oboh *et al*. (1989) analyzed 49 varieties of sweet potato sold in Nigerian markets and also reported protein contents between 1.4% and 9.4%. The protein contents of sweet potato roots from 16 cv. grown in Sri Lanka ranged from 3.0% to 7.2% on dry weight basis (dwb) (Ravindran et al., 1995).

Cambie and Ferguson (2003) reported 1.7% protein content for sweet potato while Gichuhi *et al*. (2004) reported 4.5%, 4.7%, and 9.0% protein (dwb) for cv. J6/66, Beauregard (commercial), and TU-82- 155. Bovell -Benjamin et al. (2004) observed a wide variation in the protein content of three cv. of sweet potat with TU-82-155 containing almost twice as much protein (8. 7 ± 0.1%) on dwb as J6/66 (4.4 ± 0. 03 %) and Beauregard (4 . 7 ± 0.5%). It has been argued that the mineral content of agricultural products varies with geographic location. Makki *et al*. (1986) observed that in two Egyptian sweet potato cv., the mineral in highest concentration was calcium followed by magnesium, iron, copper, zinc, and manganese. The older data reported by Ekpenyong (1984) from FAO (1972) cited phosphorous as the mineral in highest concentration for sweet potatoes. The data showed 56, 36, 0.9, 2.0, and 387 mg/100 g for phosphorus, calcium, iron, zinc, and manganese, respectively. Olaofe and Sanni (1988) reported potassium(3617 mg/100 g) as the most abundant mineral in sweet potato roots followed by magnesium (580 mg/100 g) and calcium (112 mg/100 g).Manganese, iron, copper, and zinc were present in low amounts of 8.8, 14.0, 1–5.0, and 3.0 mg/100 g, respectively.

Pushpalata *et al*. (2011) studied on 15 genotypes of sweet potato and recorded observations on starch percentage, total sugar percentage, carbohydrate percentage and TSS of Sweet potato and reported that genotypes like IGSP.C-18, 440038, 440036 and IGSP.C-16 were superior than Sree Rethna in respect of quality parameters. Vimala *et al*. (2011b) evaluated 42 orange fleshed sweet potato hybrids in upland and low land conditions for storage root yield along with a control variety of Sree Kanaka and observed that variety 106427-10 and 106035-9 possessed high β- carotene content (14.37 mg/100 g fresh weight) and dry matter content varied from 18.5-29.2%. Out of 42 hybrids studied, 22 hybrids possessed high β-carotene content (10-15 mg/100 g fresh weight).

Inspite of having numerous potential uses and benefits of Sweet potato, the production of this crop is below the potential level in many parts of the world. Sweet potato has a yield potential of 20-50 t/ha of storage roots in the tropics (Çalifikan *et al*., 2007). This yield potential is yet to be realized in Bangladesh. These low yields are as a result of several socioeconomic, biotic and abiotic constraints. Socio-economic constraints in the production of Sweet potato include, poor post-harvest handling and storage facilities, lack of processing skills, lack of clean seed and poor seed distribution system and poor agronomic varieties (Njeru *et al*., 2004; Ames *et al*., 1996).

There are several biotic constraints of sweet potato production in the tropics are sweet potato weevil (Shonga *et al*., 2013; Ehisianya *et al*., 2013), alternaria blight, sweet potato virus disease (SPVD) (McGregor *et al*., 2009) and root-knot nematodes (Meloidogyne sp) which are mostly found in the temperate zones (Grüneberg *et al*., 2009). Moisture stress due to drought is becoming a major abiotic constraint to crop production worsened by climate change (Nakashima and Yamaguchi-Shinozaki, 2013). Soil moisture availability determines the external water status at the boundaries of the plant (soil and air) and in the internal plant water status within the tissue of the plants. Drought stress reduces photosynthesis and translocation of assimilates thus reduce the yield (Anjum *et al*., 2011). Breeding drought tolerant varieties may ensure high yield production under conditions of limited water availability (Sorrells *et al*., 2000).

In Zimbabwe, thirteen pests are found to infest sweet potato tubers, stems, crowns and leaves. Only Cylas formicarius elegantulus and termites among these were not observed in this present study. Most of the insect pests identified on sweet potato in this study have been evalusated by Ames *et al*., (1996).

Bohlen, (1973), observed that although many insect species were recorded, only a few were important pests of sweet potato. The key coleopteran pests included Cylas puncticollis, Blosyrus obliqutus, Systates polinosus, and Cassid beetles. Coleopterans have also been recorded as major pests of sweet potatoes in Tanzania.

Gibson *et al*. (2000) had an experiment and found that landraces are adapted to their local areas and have developed resistance against local pests and diseases. The landraces yield are low that reduces the overall sweet potato production (Allemann *et al*., 2004). Laurie *et al*. (2008) reported low yield and yield instability due to the use of old landraces addressed by the resource-poor farmers. In Bangladesh, sweet potato can give satisfactory yield under adverse climatic and soil condition and under low or no use of external inputs (Githunguri and Migwa, 2004; Ndolo *et al*., 2001; Carey *et al*., 1999).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from November 2018 to May 2019. The materials and methods those were used and followed for conducting the experiment have been presented under the following headlines:

3.1 Experimental site

The study was conducted in the research field of Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. The location of the experimental site was 23^{o}74’ N latitude and 90^{o}35’ E longitude at an altitude of 8.6 meter above the sea level. The soil of the experiment area belongs to the Modhupur Tract under AEZ No. 28.

3.2 Climatic condition of the experimental site

The experimental site was situated in the subtropical monsoon climatic zone which was characterized by heavy rainfall during the months of April to September (Kharif season) and scanty of rainfall during rest of the year (Rabi season). Plenty of sunshine and moderately low temperature prevails in that area.

3.3 Planting materials

One of the most popular sweet potato varieties BARI Sweet Potato- 12 was used in this study. The cutting of sweet potato was collected from Tuber Crops Research Centre (TCRC) of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

BARI Sweet Potato -12 which was developed by Bangladesh Agriculture Research Institute (BARI) and released in the year of 2013 is cultivated all regions of Bangladesh. BARI Sweet Potato-12 is an orange fleshed sweet potato and the orange-fleshed varieties make sweet potato a key crop to solve the vitamin A deficiencies around the world.

3.4 Treatments of the experiment

One factor experiment was carried out in Randomized Complete Block Design (RCBD) with three replications.

Factor: The experiment was consisting of the following treatments where different doses of fertilizers acted as the treatments:

Treatments:

T_0: No fertilizer

T_1: 100% Recommended dose of BARI

T_2: Improved compost fertilizer 2kg/m^2

T_3: 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2

T_4: 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

T_5: 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2

T_6: 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

3.5 Design and layout of the experiment

One factor experiment was laid out in Randomized Complete Block Design (RCBD) with seven levels of fertilizer doses including one control treatment (no fertilizer) on the variety BARI Sweet Potato-12. Three replications (R_1, R_2, R_3) were maintained in this experiment. So, the plot combinations of the entire field were 21 (7x3). Each plot was 2m in length and 2m in width. So, the area of each plot was 4m^2.

3.6 Field preparation and application of the treatments

There were 21 plots in the field where three replications (R_1, R_2, R_3) were maintained. The treatments of the plots in each replication were elected randomly for application of different doses of fertilizers including no fertilizer dose as control treatment (T_0). BARI recommended doses of manures and fertilizers for sweet potato at the rate of 10ton-160kg-130kg-200kg- 260 kg/ ha of cow dung, Urea, TSP, MP and Gypsum were applied. Full amount of cow dung, TSP, MP and Gypsum and 50% of Urea were applied as basal dose during field preparation and the remaining amount of urea was applied as side dressed in 35 days after planting.

Again, improved compost which was made of 50kg of cowdung, 20kg of poultry manure and 10kg of vermicompost was also applied at the required rate in respected treatments. Irrigation water was applied before emergence of plants.

3.7 Transplanting of plants

Slips were transplanted at a depth of 7.5-8cm with a minimum of two plant nodes in the ground and at least two leaves or more above the ground. More nodes underground increase potential number of storage roots to be produced, while deeper planting provides the slip with a less variable environment compared to the conditions nearer the soil surface (Meyer, 2013). Transplants were planted manually on the date of November 07, 2018. The base of slips of the plants was covered with soil properly.

3.8 Intercultural operations

3.8.1 Irrigation

Light irrigation was applied right after transplanting the plants. Soil moisture appears to be the most limiting factor in determining storage root-number during the critical early developmental stages of one to 30 days after transplanting (Smith and Villordon, 2009). Sweet potato is thought to be an - at least moderately – drought tolerant crop responding very well to irrigation even if water is naturally available (Rashid, 1989; Daf, 2011; Thompson, 2014). Recommendations for irrigation regime are variable. As the plants were planted in dry conditions, 2.5 cm of water was provided weekly until 2 weeks before harvesting. According to Horvath (Date unknown), the most critical periods are the first 5-6 weeks after transplanting.

3.8.2 Weeding

Weed control is necessary in the first four to six weeks only, because later most sweet potato crops cover the ground completely and effectively shade out weeds (Horvath, 1991; Stathers *et al.*, 2013). In spite of having the ability of shading out the weeds by the sweet potato plant itself, weeding was also done in the field whenever it was necessary.

3.8.3 Vine lifting

Specialists have different opinions about the necessity of lifting vines to prevent the formation of under-developed secondary storage roots at the points where shoots nodes touch the soil surface. The effect of vine lifting on yield can depend on the variety; if it is bushy and its vines do not root, vine lifting has no effect, but if the variety is creeping with a lot of lateral roots, then vine lifting may have a positive effect on yield (Amante and O'Sullivan, Date unknown). In the tropics, lifting is usually performed once or twice during the wet season only. Vine lifting is advised not to be a routine practice, but to be undertaken only after root growth on stem nodes has been observed (Amante and O'Sullivan, date unknown). So, vine lifting was done slightly on the basis of its necessity.

3.9 Harvesting

The root tuber crop, sweet potato was harvested when it reached its maturity stage. The maturity of the plant was determined when its leaf color changed into yellow from dark green or green. Sweet potato was harvested after 130 days of transplanting.

3.10 Recording of data

Experimental data were recorded from 30 days of sowing and counted up to harvest and after harvesting. The following data were recorded during the experimentation:

A. Morphological characters

1. Vine length
2. Number of leaves/ plant
3. Number of branch/ plant

B. Yield contributing characters

1. Tuber no./ plant
2. Tuber weight/ plant
3. Marketable tuber weight (MTW)/ plant
4. Yield

C. Quality contributing characters

1. Dry weight
2. TSS% of tuber

3.11 Detailed procedures of recording data

I. Vine length

Vine length was recorded at 30, 60 and 90 days after transplanting (DAT). The length was recorded from the base of the plant to the longest end of the stem and leaf and the length was expressed in centimeter (cm).

II. Number of leaves/ plant

Number of leaves per plant was counted from each of the selected plant samples and then averaged at 30, 60 and 90 days after transplanting (DAT).

III. Number of branch/ plant

Number of branch per plant was counted from each selected plant samples and then averaged at 60 and 90 days after transplanting (DAT).

IV. Number of tuber/ plant at harvest

The number of root tubers from the plants was counted and average number of tubers was calculated at harvest.

V. Weight of tubers/ plant at harvest

The weight of root tubers from plant was recorded and average weight of tubers per plant was calculated at harvest.

VI. Marketable weight of tubers/ plant at harvest

Healthy and vigorous root tubers of sweet potato plant are considered as marketable tubers. The weight of marketable tubers from the plant was recorded and average weight of tubers per plant was calculated.

VII. Yield (Ton/ha)

Yield (ton/ha) of the tubers of plants from respected treatments was recorded and the highest and the lowest yield of the plants were also observed.

VIII. Dry weight of tubers (%)

Hundred grams of root tuber from sample plants were taken and sliced, sun dried for 2 days and then dried at 70^{o}C in an oven for 72 hours. Just after oven drying the dried pieces were weighed and were expressed in percentage.

Weight of tuber (%) = $\frac{Dry\ weight}{Fresh\ weight} \times 100$

IX. TSS (%) of tubers

TSS refers to the Total Soluble Solid and it was measured with the help of a Brix meter (Model : ATAGO Brix 0-32%, Made in Japan). The value was the average and it was found from the tubers of the selected plant samples of each treatment.

3.12 Statistical Analysis

The collected data were analyzed statistically following RCBD design by Statistix 10, a computer package programme.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the effect of inorganic and improved compost fertilizers on yield attributes and yield of sweet potato. The results obtained from the study have been presented, discussed and compared in this chapter through table(s), figures and appendices. The analysis of variance of data in respect of all the parameters has been shown in Appendix I-VI. The result have been presented and discussed with the help of table and graphs and possible interpretations were given under the following headings.

4.1 Vine Length

Vine length of BARI Sweet Potato -12 was measured at 30, 60 and 90 DAT (Days After Transplanting). It was evident from table 1 and Appendix I that the length of vine was significantly influenced by different levels of fertilizer doses at all the sampling dates. Different vine length was observed from different fertilizer doses.

At 30 DAT, the highest vine length was observed in the treatment T_3 (39.767cm) which was similar to the treatment T_2 (33.2 cm) and T_5 (31.6 cm) and they were statistically insignificant. The lowest vine length was observed in T_0 treatment (21.733 cm) followed by T_4 treatment (24.4 cm), T_6 treatment (27.267 cm) and T_1 treatment (28.333 cm).

At 60 DAT, the highest vine length was observed in the treatment T_3 (58.733 cm), which was similar to the treatment T_5 (50.733 cm) and T_2 (48.867 cm) and they were statistically insignificant. Again, the lowest plant height was shown in the treatment T_0 (30.8 cm) followed by T_4 treatment (37.667 cm), T_6 treatment (42.133 cm) and T_1 treatment (42.333 cm).

At 90 DAT, the highest vine length was observed in the treatment T_3 (72.467 cm) which was similar to the treatment T_5 (69.2 cm), T_2 (60.333 cm) and T_1 (58.733 cm) and they were statistically insignificant. The lowest vine length was observed in the treatment T_0 (34.733 cm) followed by T_4 treatment (49.667 cm) and T_6 treatment (54.900 cm).

Similar result was also observed in the experiments conducted by Johnson and Ware (1948), Stino (1953) and Samuels (1957).

Table 1 : Effect of different fertilizer doses on vine length of sweet potato at different days after transplanting

Treatments	Vine Length (cm)		
	30 DAT	**60 DAT**	**90 DAT**
T_0	21.733 c	30.800 c	34.733 d
T_1	28.333 bc	42.333 bc	58.733 abc
T_2	33.200 ab	48.867 ab	60.333 abc
T_3	39.767 a	58.733 a	72.467 a
T_4	24.400 bc	37.667 bc	49.667 cd
T_5	31.600 ab	50.733 ab	69.200 ab
T_6	27.267 bc	42.133 bc	54.900 bc
$LSD_{(0.05)}$	**8.8223**	**13.876**	**15.103**
CV (%)	**16.83**	**17.54**	**14.86**

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 5% level of significance

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.2 Number of leaves/plant

The number of leaves per plant was significantly influenced by different fertilizer doses at 30, 60 and 90 DAT (Table 2 and Appendix II). Variations in the number of leaves per plant were observed in different fertilizer doses.

At 30 DAT, the highest leaf no./plant was observed in the treatment T_3 (42.067) which was similar to the treatment T_2 (40.533) and they were statistically insignificant. On the other hand, the lowest leaf number was observed in the treatment T_0 (17.933) followed by T_1 treatment (21.200) and T_4 treatment (21.933).

At 60 DAT, the highest leaf no./plant was observed from the treatment T_5 (107.57) which was similar to the treatment T_3 (103.03) and T_6 (90.20) and they were statistically insignificant. Again, the lowest leaf number was observed in the treatment T_0 (39.80) which statistically showed significant difference from the other treatments.

Similarly, at 90 DAT, the highest leaf number was observed from the treatment T_5 (148.23) which was similar to the treatment T_3 (126.73) and they were statistically insignificant to each other. The lowest leaf number was observed in the treatment T_0 (56.73) which differed significantly from the other treatments.

This variation was also experimented and observed by Laurie *et al.* (2013) Worhtington (1998) and Teklu et al. (1999-2001).

Table 2: Effect of different fertilizer doses on leaf number/plant of sweet potato in different days after transplanting

Treatments	Leaf No./plant		
	30 DAT	60 DAT	90 DAT
T_0	17.933 d	39.80 e	56.73 d
T_1	21.200 cd	68.87 d	120.87 b
T_2	40.533 a	73.77 cd	108.77 bc
T_3	42.067 a	103.03 ab	126.73 ab
T_4	21.933 bcd	87.93 bc	93.47 c
T_5	29.933 b	107.57 a	148.23 a
T_6	26.600 bc	90.20 abc	119.80 b
$LSD_{(0.05)}$	**8.5610**	**18.058**	**24.091**
CV (%)	**16.83**	**12.44**	**12.24**

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 5% level of significance

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.3 Number of branch/plant

The number of branch per plant of BARI Sweet Potato -12 was significantly influenced due to different fertilizer doses at 60 DAT and 90 DAT (Fig. 1 and Appendix III).

At 60 DAT, the highest branch no./plant was observed in the treatment T_2 (15.867) which was followed by the treatments T_6 (14.600), T_5 (13.800), T_3 (13.067), T_1 (13.067) and T_4 (12.933) and they were statistically insignificant. On the other hand, the lowest branch no./plant was observed from the control one T_0 (9.200) which was statistically different from other treatments.

At 90 DAT, the highest branch no./plant was observed from the treatment T_2 (20.867) which was followed by the treatments T_6 (19.133), T_5 (18.600) and T_4 (17.667) and they were statistically insignificant to each other. And the lowest branch number was shown in the T_0 treatment (13.200) which showed significant variation from the other treatments.

The finding was similar and justified by the findings of Roy *et al.* (2006) and Liu *et al.* (2013).

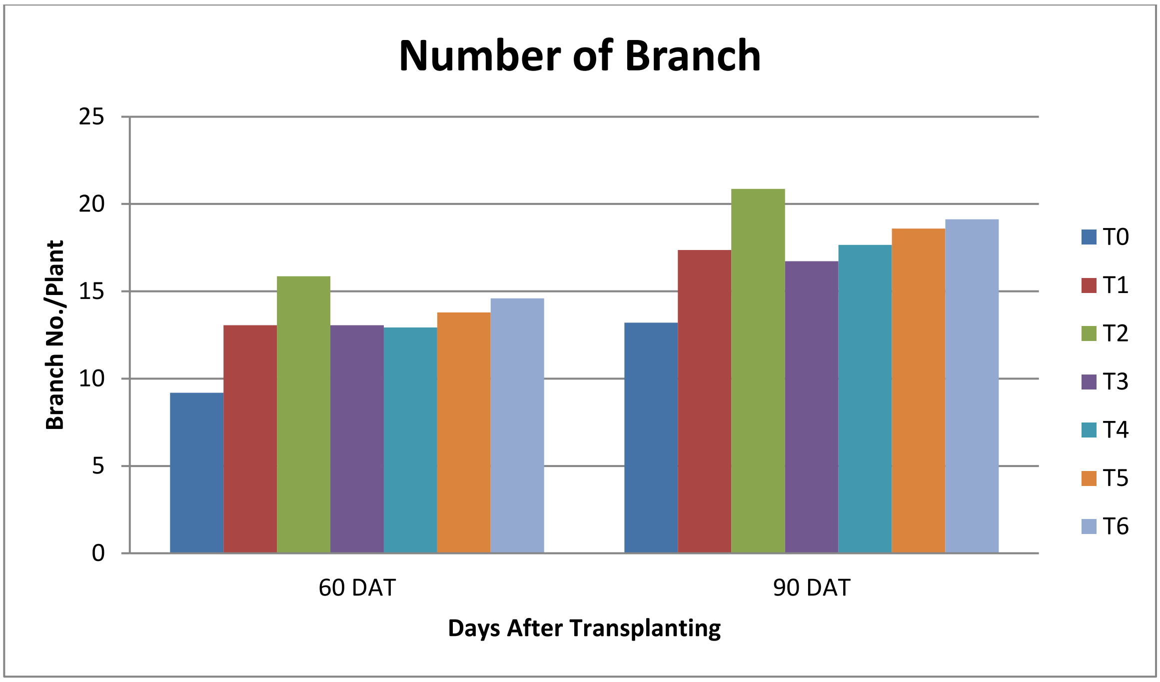

Fig 1: Effect of different fertilizer doses on branch number/plant of sweet potato in different days after transplanting

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.4 Number of tuber/plant

The number of tubers per plant was significantly influenced by different levels of fertilizer doses (table-3 and Appendix- IV). The highest number of tubers was observed in the treatment T_6 (6.0333) which was similar to the treatment T_5 (5.50) and treatment T_2 (5.1333) and they were statistically insignificant.

On the other hand, the lowest number of tuber was found from the treatment T_0 (2.7333) followed by T_4 (3.6333) and T_1 (3.6667). They were also statistically insignificant to each other where T_3 (3.9333) showed significant variation with T_0 as well as with the highest one T_6 .

Similar result was also found from the experiments conducted by Jian-wei *et al.* (2001), Uwah *et al.* (2013) and Dumbuya (2015).

Table 3: Effect of different fertilizer doses on tuber number per plant of sweet potato at harvest

Treatments	Tuber No./ Plant
T_0	2.7333 c
T_1	3.6667 bc
T_2	5.1333 a
T_3	3.9333 b
T_4	3.6333 bc
T_5	5.5000 a
T_6	6.0333 a
$LSD_{(0.05)}$	**1.0577**
CV (%)	**13.59**

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 5% level of significance

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.5 Tuber weight per plant at harvest

The weight of tuber per plant at harvest was significantly influenced by fertilizer doses at different levels. From Fig.2 and Appendix IV it can be observed that the highest tuber weight/plant was obtained from the treatment T_5 (1.1627 kg) which was similar to the treatment T_3 (1.0817 kg) and T_6 (0.9343 kg) and they were statistically insignificant where the lowest tuber weight/plant was shown in the treatment T_0 (0.3857 kg). T_0 treatment showed statistically significant variation with all other treatments.

Tuber weight/plant which is one of the yield contributing characters showed significant variations due to different doses of fertilizer treatments and these variations were also previously found by different researchers like Uwah et al. (2013), Dumbuya (2015) and El-Baky et al. (2010).

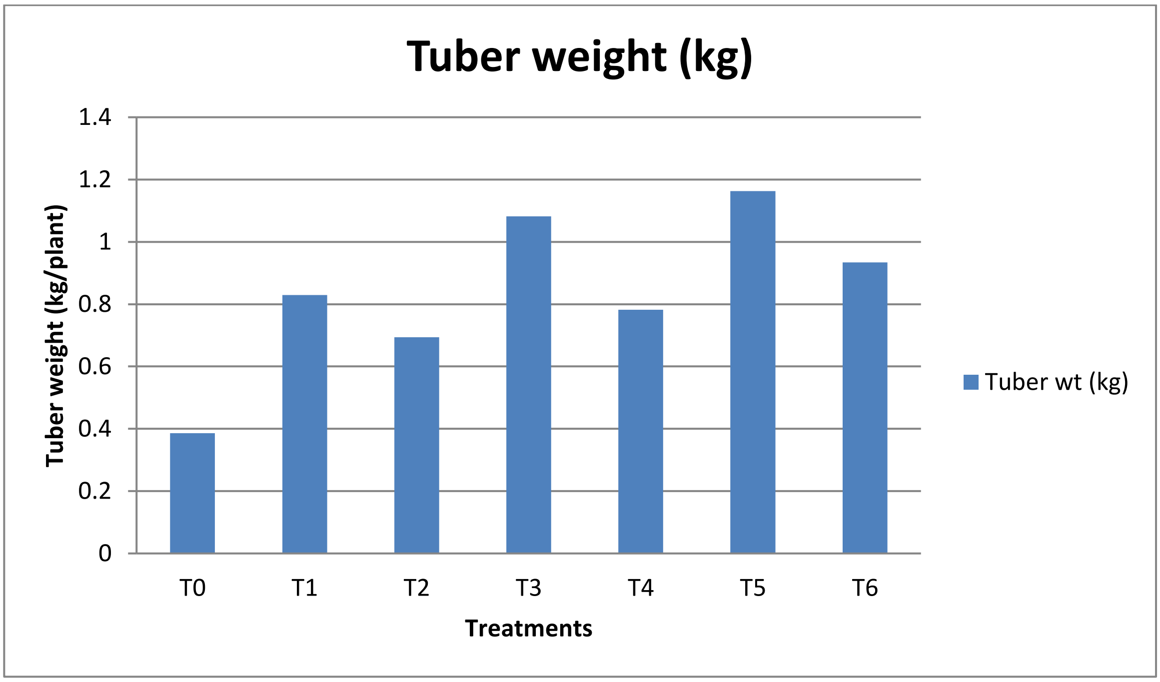

Fig.2: Effect of different fertilizer doses on tuber weight/plant of sweet potato

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.6 Marketable Tuber Weight (MTW)/ plant

Marketable tuber weight per plant of sweet potato was also affected by different fertilizer doses. Considering Fig. 3 and Appendix IV it can be noticed that the marketable tuber weight/plant showed significant variation due to different levels of fertilizer doses. The highest MTW was observed in the treatment T_3 (1.0717 kg) which was similar to the treatment T_5 (1.0627 kg) and they were statistically insignificant to each other.

On the other hand, the lowest marketable tuber yield per plant was found in the treatment T_0 (0.2900 kg) followed by T_2 (0.6217 kg), T_1 (0.7007 kg), T_4 (0.7317 kg) and T_6 (0.8343 kg). They were statistically significant to each other.

This kind of variation was observed due to different levels of organic and inorganic fertilizer doses and these variations were also found by some other researchers like Roy *et al.* (2006), Smith and Villordon (2009), Uwah *et al.* (2013) and Dumbuya (2015) which justified this experiment.

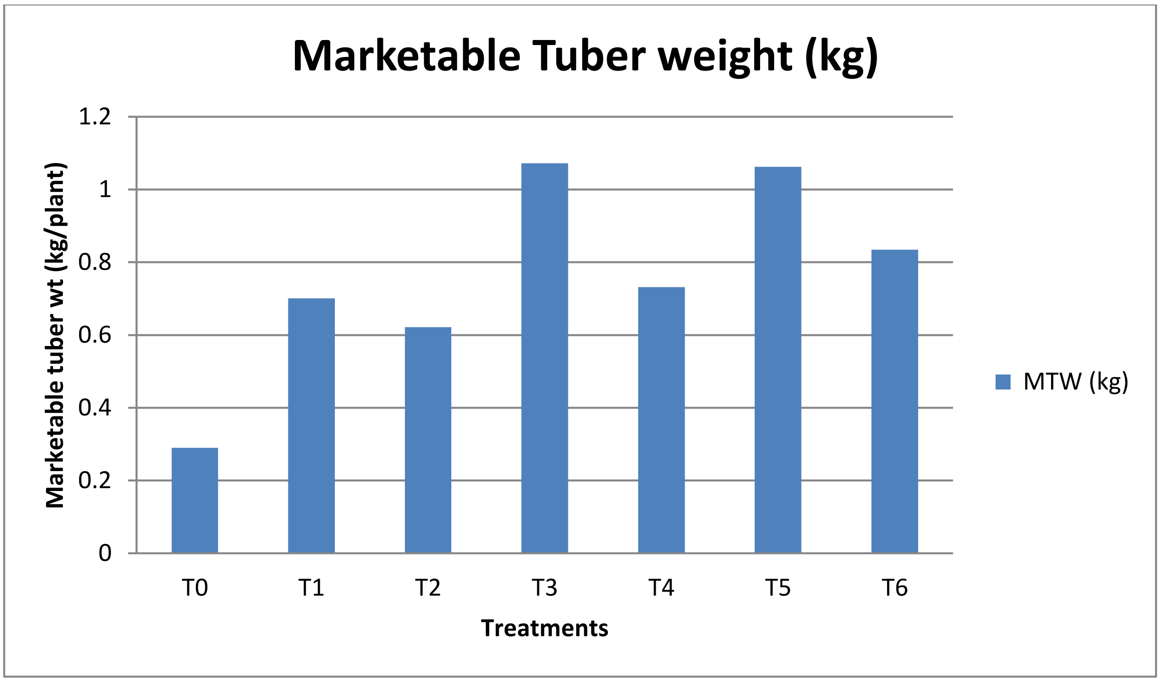

Fig. 3: Effect of different fertilizer doses on marketable tuber weight (MTW) of sweet potato

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.7 Yield

Yield of BARI Sweet Potato- 12 which was obtained at harvest varied significantly with different levels of fertilizer treatments.

From table 4 and appendix V it was found that the highest tuber yield (ton/ha) was obtained from the treatment T_5 (43.604 ton/ha) which was similar to the treatment T_3 (40.569 ton/ha) and T_6 (35.039 ton/ha) and they were statistically insignificant to each other. Again, the lowest yield was found in the treatment T_0 where no fertilizer was used and the lowest yield was 14.465 ton/ha.

The lowest tuber yield which was found from the treatment T_0 was followed by T_2 treatment (26.027 ton/ha), T_4 treatment (29.317 ton/ha) and T_1 treatment (31.107 ton/ha). T_0 treatment varied significantly from these other treatments.

T_5 treatment which showed the highest yield (ton/ha) was the combination of 100% recommended dose of BARI and 1kg improved compost fertilizer/m^2. As 100% BARI dose was used in this treatment including different inorganic fertilizers like NPK, many researchers also found similar impact of inorganic fertilizer on sweet potato yield like Stoddard (2015), Pulok et al. (2016), Uwah et al. (2013), Dumbuya (2015) and Liu et al. (2013) which justified the experiment as well.

Table 4: Effect of different fertilizer doses on yield (ton/ha) of sweet potato at harvest

Treatments	**Yield (ton/ha)**
T_0	14.465 d
T_1	31.107 bc
T_2	26.027 c
T_3	40.569 a
T_4	29.317 bc
T_5	43.604 a
T_6	35.039 ab
LSD $_{(0.05)}$	**8.6179**
CV (%)	**15.40**

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 5% level of significance

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.8 Dry weight of tuber

The effect of different fertilizer doses showed a statistically insignificant variation on the dry weight (gm) of sweet potato tubers (Table 5 and Appendix VI).

The highest dry weight was observed in the treatment T_1 (19.533 gm) followed by T_5 (19.300 gm), T_3 (18.567 gm), T_6 (17.967 gm), T_0 (17.900 gm), T_4 (17.300 gm) and finally the lowest one was observed in the treatment T_2 (16.933 gm). There were no significant differences among these treatments in case of dry weight (gm).

Dry weight is one of the quality parameters of sweet potato root tuber. Some other researchers like Jarvan (2006) and AOAC (1984) who worked with organic and mineral fertilizers also found no significant differences in the quality of crop. So, this also justifies the experiment.

Table 5: Effect of different fertilizer doses on dry weight (gm) of sweet potato

Treatments	Dry Weight (gm)
T_0	17.900 a
T_1	19.533 a
T_2	16.933 a
T_3	18.567 a
T_4	17.300 a
T_5	19.300 a
T_6	17.967 a
$LSD_{(0.05)}$	**NS**
CV (%)	**8.40**

In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 5% level of significance

NS = Non Significant

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

4.9 TSS% of Tubers

The effect of different fertilizer doses worked significantly on TSS% of sweet potato tubers. From Fig. 4 and Appendix VI the highest TSS% was observed in the treatment T_5 (9.9333) which was similar to the treatment T_2 (9.5667) and they were statistically insignificant. Similarly, the lowest TSS% was shown in the treatment T_1 (8.5667) followed by T_6 (8.6333), T_3 (9.0333) and T_0 (9.1333).

Similar results were also found by Jarvan (2006), AOAC (1984) and Worhtington (1998) which is the justification of the experiment as well.

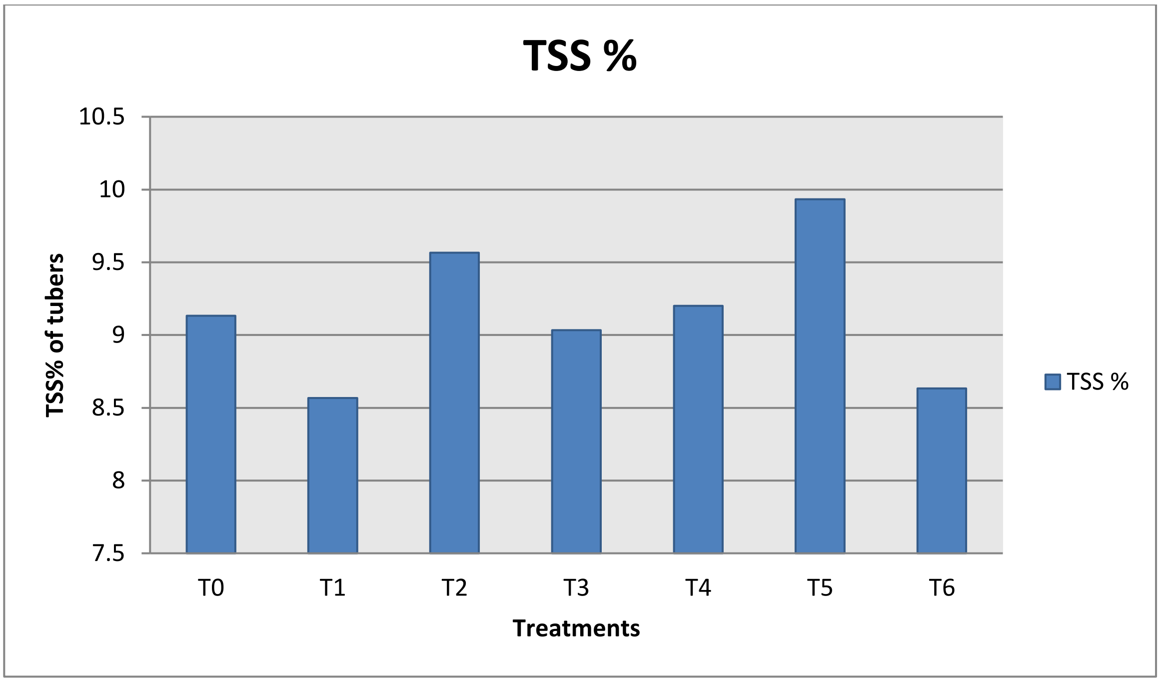

Fig. 4: Effect of different fertilizer doses on TSS% of sweet potato tubers

T_0= No fertilizer, T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% Recommended dose of BARI+ 1 kg improved compost fertilizer/m^2, T_4= 50% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2, T_5= 100% Recommended dose of BARI+ 1kg improved compost fertilizer/m^2, T_6= 100% Recommended dose of BARI+ 2kg improved compost fertilizer/m^2

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in the research field of Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka- 1207, Bangladesh, during the period from November 2018 to March 2019 to observe the effect of inorganic and improved compost fertilizer on yield attributes and yield of sweet potato. In the experiment the treatment consisted of seven levels of fertilizer doses viz. T_o= without fertilizer (control), T_1= 100% Recommended dose of BARI, T_2= Improved compost fertilizer 2kg/m^2, T_3= 50% rec. dose of BARI+1 kg improved compost fertilizer/m^2, T_4= 50% rec. dose of BARI+2 kg improved compost fertilizer/m^2, T_5= 100% rec. dose of BARI+1 kg improved compost fertilizer/m^2, T_6= 100% rec. dose of BARI+ 2kg improved compost fertilizer/m^2 and the variety was BARI Sweet Potato – 12. The one factor experiment was laid out in Randomized Complete Block Design (RCBD) with these seven levels of fertilizer doses. Three replications were maintained in this experiment.

Vine length of the plants was significantly influenced by different levels of fertilizer doses. The highest vine length (39.767cm, 58.733 cm and 72.467cm at 30 DAT, 60DAT and 90 DAT respectively) was observed from the treatment T_3 (50% rec. dose of BARI+ 1 kg improved compost fertilizer/m^2) where T_0 (no fertilizer) showed the lowest vine length (21.733cm, 30.80 cm and 34.733cm at 30 DAT, 60 DAT and 90 DAT respectively).

The number of leaves was significantly different due to the effect of different fertilizer doses. In this case T_3 treatment (50% rec. dose of BARI+ 1 kg improved compost fertilizer/m^2) showed the highest value of leaf number (42.067) at 30 DAT where treatment T_5 (100% rec. dose of BARI+1 kg improved compost fertilizer/m^2) showed the highest result (107.57 and 148.23) at 60 DAT and 90 DAT respectively. But the control treatment (T_0= No fertilizer) again showed the lowest leaf numbers (17.933, 39.80, 56.73) per plant at each of 30 DAT, 60 DAT and 90 DAT respectively.

Again, in case of branch no./plant T_2 treatment showed the highest value in different days after transplanting (15.867 and 20.867 at 60 DAT and 90 DAT respectively). Here, T_2 refers to the application of only improved compost fertilizer 2kg/m^2 in the field. And

T_0 (control treatment) also showed the lowest branch no./plant (9.200 and 13.200) both at 60 DAT and 90 DAT respectively.

In case of yield contributing characters like the number of tuber/plant it was observed that the tuber no. was significantly influenced by the effect of different fertilizer doses. The highest tuber no/plant (6.0333) was observed from the treatment T_6 and here T_6 means the application of 100% recommended BARI dose + 2 kg improved compost fertilizer/m^2. On the other hand, the lowest tuber no./plant was found from the treatment T_0 (control) and it was 2.7333.

Again, weight of tubers/plant was also significantly influenced by different levels of fertilizer doses. The highest tuber weight was observed from the treatment T_5 where T_5 refers to 100% recommended BARI dose+1 kg improved compost fertilizer/m^2. The highest tuber weight/plant was 1.1627 kg where the lowest result (0.3857 kg/plant) was obtained from the treatment T_0 (control).

In case of marketable tuber weight (MTW), the highest tuber weight was found from the treatment T_3 (50% rec. dose of BARI+1 kg improved compost fertilizer/m^2) and the tuber weight value obtained from this treatment (T_3) was 1.0717 kg/plant. Similarly, the lowest MTW was obtained from the control treatment (T_0) in this case also and the lowest value was 0.2900 kg/plant.

Again, the yield (ton/ha) of BARI Sweet Potato-12 varied significantly with different levels of fertilizer doses. The highest tuber yield(ton/ha) was obtained from the treatment T_5 (43.604 ton/ha) where the lowest yield was found from the treatment T_0 where no fertilizer was used and the lowest yield was 14.465 ton/ha. Here, T_5 refers to the application of 100% rec. dose of BARI+1 kg improved compost fertilizer/m^2.

However, in case of quality parameters like dry weight, the fertilizer doses showed insignificant variations on the plants. There was no significant difference in dry weight from the effect of different levels of fertilizer doses. Here, the highest value (19.533 gm) was observed from the treatment T_1 which indicates the application of 100% recommended doses of BARI and the lowest one (16.933 gm) was observed from the treatment T_2 where T_2 means application of improved compost fertilizer 2kg/m^2.

TSS%, another quality parameter, was significantly influenced by different levels of fertilizer doses. The highest value (9.9333) was obtained from the treatment T_5 where the lowest one (8.5667) was observed from the treatment $T_{1.}$ Here, T_5 refers to 100%

recommended BARI dose+ 1 kg improved compost fertilizer/m^2 and T_1 refers to the application of only 100% recommended dose of BARI.

Considering the result of the present experiment, it can be said that the growth, yield and quality of BARI sweet potato- 12 showed different results in different treatments. But in most of the cases T_5 (100% recommended BARI dose+ 1 kg improved compost fertilizer/m^2) showed better results specially the highest yield (43.604ton/ha) was obtained from this treatment (T_5). And then comes T_3 treatment (50% recommended BARI dose+ 1 kg improved compost fertilizer/m^2) which also showed comparatively better results than the other treatments after T_5. On the other hand, control (T_o= No fertilizer) one showed the lowest growth as well as yield (14.465 ton/ha) results in most of the cases.

So, it can be concluded from the experiment that 100% recommended BARI dose+ 1kg improved compost fertilizer/m^2 (T_5) is the best treatment to apply for obtaining better growth and yield from BARI Sweet Potato-12 plant.

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APPENDICES

Appendix I: Analysis of variance of the data on vine length of sweet potato as influenced by different fertilizer doses at days of planting

Source	Degrees of freedom	Mean Square		
		Vine Length		
		30 DAT	60 DAT	90 DAT
Replication	2	30.584*	18.059*	27.206*
Treatment	6	108.089*	252.591*	478.007*
Error	12	24.593	60.837	72.072

*significant at 5% level of probability

Appendix II : Analysis of variance of the data on number of leaves per plant of sweet potato as influenced by different doses of fertilizer at days of planting

Source	Degrees of freedom	Mean square		
		Number of leaf per plant		
		30 DAT	60 DAT	90 DAT
Replication	2	7.240*	23.70*	716.34*
Treatment	6	271.258*	1609.23*	2532.55*
Error	12	23.158	103.04	183.39

*significant at 5% level of probability

Appendix III : Analysis of variance of the data on number of branch per plant of sweet potato as influenced by different doses of fertilizer at days of planting

Source	Degrees of freedom	Mean Square	
		Number of branch per plant	
		60 DAT	90 DAT
Replication	2	24.4648*	15.6376*
Treatment	6	12.7676*	17.0865*
Error	12	3.2114	3.3398

*significant at 5% level of probability

Appendix IV: Analysis of variance of the data on yield contributing characters of sweet potato as influenced by different doses of fertilizer

Source	Degrees of freedom	Mean Square		
		Tuber No. /plant	Tuber weight/ plant	Marketable tuber weight/ plant
Replication	2	0.78905*	0.00420*	0.00100*
Treatment	6	4.26635*	0.20133*	0.21931*
Error	12	0.35349	0.01666	0.01157

*significant at 5% level of probability

Appendix V: Analysis of variance of the data on yield (ton/ha) of sweet potato as influenced by different doses of fertilizer

Source	Degrees of freedom	Mean Square (Yield)
Replication	2	5.958*
Treatment	6	283.167*
Error	12	23.467

*significant at 5% level of probability

Appendix VI : Analysis of variance of the data on quality parameters of sweet potato as influenced by different doses of fertilizer

Source	Degrees of freedom	Mean Square	
		Dry weight	TSS%
Replication	2	2.60143*	0.11476*
Treatment	6	2.83984^{NS}	0.70540*
Error	12	2.34365	0.11087

NS- Non Significant

*significant at 5% level of probability

SOME PHOTOGRAPHS OF THE RESEARCH FIELD AND LABORATORY WORK

Plate 1: Planting of sweet potato vines

Plate 2: Planting of sweet potato vines

Plate 3: Irrigation after transplanting of sweet potato vines

Plate 4: Irrigation after transplanting of sweet potato vines

Plate 5: BARI Sweet Potato- 12 plant at 45 DAT

Plate 6: Field condition at 45 DAT

Plate 7: Field condition at 45 DAT after irrigation

Plate 8: Application of fertilizer in the field

Plate 9: Field condition at 120 DAT of sweet potato plant

Plate 10: Signboard with plot location and researcher

Plate 11: Harvesting of BARI Sweet Potato- 12

Plate 12: Harvesting of sweet potato in the field

Plate 13: Cutting of 100gm of sweet potato for taking dry weight

Plate 14: Sun drying of sweet potato slices

Plate 15: Taking preparation for oven drying

Plate 16: Taking the value of TSS% using Brix meter